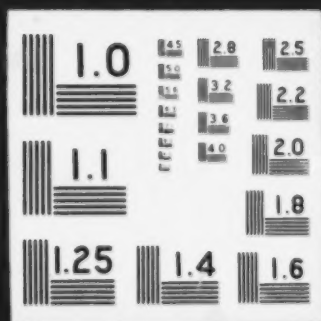


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Community Air Pollution Program

A paper presented at the Air and Water Pollution Conference,
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THE NATIONAL AIR SAMPLING NETWORK

The National Air Sampling Network of the Public Health Service, established in 1953, is operated in cooperation with local health departments, air pollution agencies and other organizations. By November 1, 1957 the network was composed of 110 stations in major cities in the 48 states, the District of Columbia, Alaska, Hawaii and Puerto Rico, and approximately 30 stations in comparatively remote nonurban areas. A report has been presented on the results of the first three years of operation and on plans for the future of the network (1).

The objectives of the network are to assemble basic data on the nature and extent of the pollution of the air over the United States; to show trend with time, geographical variation, and the influence of topography, population, climate, industry, and other variables; and to provide data against which epidemiological findings may be correlated.

Samples collected for one 24-hour period in each two weeks are mailed to Cincinnati for analysis. The sampling is done on a random schedule determined by statistical methods. The air particulate matter is collected on 8 x 10 inch weighed glass fiber filters, using high-volume samplers which draw approximately 2000 m³ of air through a filter in an average 24-hour sampling period. Weight of the particulate matter collected varies from a few milligrams to a few grams, depending on the atmospheric loading.

All samples are analyzed for suspended particulate matter, benzene-soluble organics, and β -radioactivity, while selected samples are analyzed for certain inorganic constituents. Reports of findings are sent to the participating agencies at regular intervals. The information in these reports may be used as desired by the individual agency.

After the sample is weighed, the β -radioactivity is measured. Then the filter is cut in such a way that the 7 x 9 inch sample area is divided into equal parts, one of which is used for extraction of organic materials and the other for the determination of inorganic constituents. After six circles, each comprising 4% of the total area, have been removed from the second half of the sample for various determinations, the remainder is used for metal analysis.

SUSPENDED PARTICULATE MATTER

Since the weight of the collected material is easily determined and the total volume of air sampled can be calculated, the weight of suspended particulate matter per unit volume of air filtered may be obtained. Levels are expressed in micrograms of particulate matter per cubic meter of air. A preliminary report was presented in April, 1955 (2) covering several cities, for 1953, 1954, and early 1955. The frequency distributions of particulate levels of several urban and suburban stations for 1953-1956 are shown in Table 1. The cities in the table are arranged in order of decreasing population. By 1957 all suburban stations were discontinued in favor of nonurban sites more remote from sources of pollution.

In general it can be stated that the higher particulate levels are found in the atmosphere of larger cities, except that smaller, heavily industrialized cities may also show high levels. Suburban stations showed considerably lower levels than nearby urban stations.

ORGANIC MATTER

The organic portion of the particulate sample is isolated by extraction with the selected solvent in a Soxhlet extractor for 6-8 hours.

The solution containing the organic material is filtered through a medium porosity, fritted glass filter, the solvent removed and the weight of the residue determined. The amount of organic matter is reported in micrograms per cubic meter of air.

Originally acetone was used as the solvent because it removed a greater amount of organic matter than any other common solvent. These acetone extracts were difficult to handle when used for further chemical studies, and also contained considerable inorganic matter. Therefore, the use of this solvent was discontinued at the first opportunity. A preliminary report has been presented on the levels of acetone soluble materials from several cities (3).

Since July 1, 1955, all samples have been extracted with redistilled benzene which, while it does not remove all the organic material present, does provide a more useful product for further experimentation. The distribution of benzene soluble organic matter in the atmosphere of several communities is shown in Table 2. This table bears considerable resemblance to Table 1.

In addition to determining the amount of organic material in the atmosphere, considerable effort has been expended on the investigation of the chemical nature of this material. Infrared spectroscopy provides a convenient method of detecting qualitative differences between samples of organic matter. Therefore, infrared spectra of a large number of organic extracts have been obtained. Examples of a few different observations based on these spectra are: variation in the nature of the organic material at different sites within a city, variation in the composition of the organic matter with the seasons, and variation in the nature of the organic matter

from city to city. An outstanding demonstration of the value of this technique was the detection of caffeine in samples collected in New Orleans.

Increased interest in the organic portion of suspended particulate matter has led to further chemical studies designed to provide information on the composition of this fraction. A sample of the crude organic matter, obtained by pooling a sufficient number of individual extracts, is easily separated by standard chemical procedures into the following groups of organic compounds: basic, weak acid, strong acid, aliphatic hydrocarbons, aromatic hydrocarbons, and oxygenated neutrals. A preliminary report on the characteristics of atmospheric organic materials has been presented (4). Table 3 shows the results of analysis of a few samples of such materials. Particularly outstanding are the aliphatic fraction from St. Bernard and the acid fraction from Los Angeles. Further work on identification of individual components of the various fractions is in progress.

RADIOACTIVITY

From the beginning, a large proportion of network samples have been measured for β -radioactivity, and a limited number for α -activity. Currently, β -activity determinations are being made on all samples. These β counts are extrapolated to the date of sample collection to correct for decay. Typical results are shown in Table 4.

INORGANIC MATERIALS

In the early days of the network, analysis of samples for inorganic materials was carried out by the Kettering Laboratory of the University of Cincinnati College of Medicine. Since July, 1955, all such analyses have been done in the network laboratories. The present analytical program

calls for the analysis of selected samples for the following: antimony, bismuth, barium, beryllium, cadmium, copper, chromium, cobalt, iron, lead, manganese, molybdenum, nickel, tin, titanium, vanadium, zinc, nitrates, and sulphates. In the past, chlorides were determined for a large number of samples, but the filters now being used contain such a large amount of soluble chlorides that this measurement has been discontinued.

The results of analysis of selected samples from 20 communities for the metals, have been reported (5), while data from 25 others have yet to be evaluated. The metal concentrations are measured by emission spectrographic techniques using a nitric acid extract of the sample which has been heated in a muffle furnace to burn off organic matter prior to the acid extraction.

Iron, zinc, copper, lead and manganese were the metals found in the largest amounts in the samples analyzed. The maximum levels for iron, zinc, copper and lead were well over $10 \mu\text{g}/\text{m}^3$ and, except for copper, numerous samples from several cities were well over the $1 \mu\text{g}/\text{m}^3$ level. In the case of manganese the maximum level was $3 \mu\text{g}/\text{m}^3$ with relatively few samples above $1 \mu\text{g}/\text{m}^3$. The method of presentation of typical atmospheric metal data, shown in Table 5, minimizes slight differences in levels and provides a convenient basis for showing trends from year to year.

Barium, bismuth, cadmium, chromium, nickel, tin, titanium, and vanadium were quite widely distributed, but in much smaller quantities than those metals listed in the preceding paragraph. The maximum values, except for barium, were considerably under $1 \mu\text{g}/\text{m}^3$ and in many instances the ranges of concentration were quite small. These data have been presented in the same manner as for lead.

The number of samples containing detectable quantities of antimony, beryllium, cobalt and molybdenum was so small and represented so few communities that there is little value in attempting a detailed analysis of the data. The major point is the apparent absence of detectable amounts of these four elements from the atmospheres of a large number of cities.

Variations in maximum levels found among the various communities are shown in Table 6. As was to be expected, most of the high maxima were associated with the more heavily industrialized communities.

Sulphates, nitrates and chlorides have been determined on a large number of samples by wet chemical procedures. No report has as yet been presented on the findings. Maximum levels found in several communities are shown in Table 7.

SUMMARY

The foregoing illustrates the type of information currently being obtained by the National Air Sampling Network.

It is recognized that full assessment of air quality requires more information than can be supplied by analysis of suspended particulate matter collected on filters. A concentrated effort is being made to develop a simple, inexpensive means for sampling and analyzing those gaseous pollutants not caught or absorbed by filters.

Development of an automatic computer program with punched card input and output and direct automatic typing of final data tabulations will expedite the evaluation of the large amount of data being accumulated in the network program. Such tabulations will be incorporated in a detailed report of network operations from 1953 through 1956 which is being prepared.

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Table 1. FREQUENCY DISTRIBUTION OF PARTICULATE LEVELS

Percent of Samples

Stations	Range, $\mu\text{g}/\text{m}^3$					Over 500
	0-99	100-199	200-299	300-399	400-499	
URBAN						
Chicago, Ill.	5	24	31	22	8	9
New York, N. Y.	2	30	48	18	1	1
Boston, Mass.	26	61	10	2	1	0
St. Louis, Mo.	0	45	41	7	1	4
Denver, Colo.	20	55	19	5	0	0
Minneapolis, Minn.	39	54	7	0	0	0
Atlanta, Ga.	21	63	13	2	1	0
Tampa, Fla.	62	37	1	0	0	0
Charleston, W. Va.	21	25	11	17	13	12
East Chicago, Ind.	6	32	26	23	10	3
SUBURBAN						
Boston, Mass.	94	6	0	0	0	0
Lakehurst, N. J.	99	1	0	0	0	0
Tampa, Fla.	91	7	2	0	0	0

Table 2. FREQUENCY DISTRIBUTION OF ORGANIC LEVELS

Percent of Samples

Stations	Range, $\mu\text{g}/\text{m}^3$					
	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	Over 50
URBAN						
Chicago, Ill.	17	34	32	12	4	1
New York, N. Y.	51	41	4	2	2	0
Boston, Mass.	28	63	7	1	0	1
St. Louis, Mo.	26	48	17	4	3	2
Denver, Colo.	38	48	8	6	0	0
Minneapolis, Minn.	72	23	2	2	1	0
Atlanta, Ga.	37	46	7	5	0	5
Tampa, Fla.	73	23	3	0	0	0
Charleston, W. Va.	41	41	7	7	0	4
SUBURBAN						
Boston, Mass.	94	1	2	0	0	0
Lakehurst, N. J.	98	2	0	0	0	0
Tampa, Fla.	94	6	0	0	0	0

Table 3. PERCENTAGE DISTRIBUTION OF ORGANIC CLASSES IN BENZENE EXTRACTS

Class	St. Bernard, O.	Los Angeles	Philadelphia
Insolubles	2.0	13.3	8.7
Water Solubles	1.0	5.5	2.4
Esters	1.2	0.2	0.6
Weak Acids	2.7	7.0	5.0
Strong Acids	1.1	9.7	3.3
Aliphatics	65.5	19.6	27.5
Aromatics	14.2	14.2	22.2
Oxy-neutrals	6.8	17.6	19.1

Table 4. RADIOACTIVITY OF SUSPENDED PARTICULATE MATTER

Date collected*	Date counted	Sample No.	Sta. No.	Activity per Cubic Meter		
				Alpha** mμc	Beta** μc	Beta*** μc
11/5/54	11/26	1600	A	3	1.09	2.00
11/12	12/13	1926	A	7	2.42	4.00
11/12	12/9	1927	A	11	2.59	4.60
11/18	1/6/55	1928	A	8	1.87	5.20
11/18	1/18	1929	C	7	1.06	3.05

* 24-hour sampling period.

** When counted.

*** Extrapolated to time of collection.

Table 5. FREQUENCY DISTRIBUTION OF LEAD LEVELS

Percent of Samples

Location*	No. of samples	Range, $\mu\text{g}/\text{m}^3$					
		0-.25**	.25-.63	.63-1.6	1.6-3.9	3.9-9.8	9.8-17.5
All Cities	754	15.6	33.3	34.1	11.5	4.5	0.9
Houston	62	0	15	27	21	27	10
Boston, E. Chicago, Louisville, Salt Lake City	203	8	31	37	17	7	
Chattanooga, Chicago, Denver, E. St. Louis, Houston C, New York Philadelphia, <u>Portland</u> , Washington	314	9	34	43	14		
Boston C, Ft. Worth, Jersey City, <u>Minneapolis</u> , New Orleans, <u>Pauls-</u> <u>boro</u> , Tampa	158	36	46	18			

Lakehurst

17 82 18

**Minimum detectable quantity - $.1\mu\text{g}/\text{m}^3$

*Nonurban indicated by underline.

Table 6. RANGE OF MAXIMUM METAL LEVELS

Metal	Low level		High level	
	Location*	$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	Location*
Zinc	Fort Worth	0.4	49.	Chicago
Iron	<u>Lakehurst</u>	0.23	30.	East Chicago
Copper	Washington	0.05	30.	<u>Boston C</u>
Lead	<u>Lakehurst</u>	0.33	17.	Boston
Manganese	<u>Lakehurst & Paulsboro</u>	<0.01	3.	Chattanooga
Barium	<u>Lakehurst & Paulsboro</u>	<0.005	1.5	Houston
Tin	Tampa	0.004	0.8	Boston
Vanadium	Fort Worth	0.002	0.6	Jersey City
Titanium	New Orleans & Tampa	0.01	0.24	East Chicago
Nickel	<u>Houston C</u>	0.005	0.2	East St. Louis New York
Chromium	<u>Lakehurst</u>	<0.002	0.12	East Chicago
Cadmium	Boston	0.002	0.10	East St. Louis
Bismuth	<u>Boston C</u> <u>Minneapolis</u>	<0.002	0.03	New York

*Nonurban indicated by underline.

Table 7. MAXIMUM LEVELS OF ATMOSPHERIC CHLORIDES, NITRATES AND SULFATES

Location	$\mu\text{g}/\text{m}^3$		
	Chlorides	Nitrates	Sulfates
Philadelphia	1.2	8.0	85
Charleston, W. Va.	1.0	2.2	37
Atlanta	3.5	2.6	33
Cincinnati	1.3	3.3	27
East Chicago	3.5	6.7	50
San Francisco	43.0	3.4	22
Anchorage - Suburban	0.3	0.2	7
Denver - Suburban	0.3	1.2	7